Relationship between Mobility-Related Activities of Daily Living and Health-Related Quality of Life among Healthy Older Adults: A Cross-Sectional Study Using Structural Equation Modeling

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Abstract

Objective: To develop a conceptual model that confirms whether mobility-related activities of daily living (ADLs) abilities are strongly associated with reduced health-related quality of life (HRQOL) in older adults. **Methods:** A total of 153 participants (63 men, 90 women) were analyzed. The mobility-related ADL survey from the Ministry of Education, Culture, Sports, Science, and Technology of Japan was used. The Japanese version (v1.2) of the Medical Outcomes Study 36-item Short-Form Health Survey was administered to evaluate HRQOL. Structural equation modeling was performed to test a hypothetical model: mobility-related ADL abilities would influence HRQOL. **Results:** The chi-square value was not significant (chi-square = 9.463, p = .305), and goodness-of-fit values were high, implying that the model was validated; goodness-of-fit index, 0.981; adjusted goodness-of-fit index, 0.949; comparative fit index, 0.996; and root mean square error of approximation, 0.035. Results showed that mobility-related ADL abilities influenced the physical health including physical function and general health in HRQOL. **Conclusions:** This study developed the conceptual model confirming the influence of mobility-related ADL abilities especially on physical health. Further intervention studies on instructions/training for physical activity of healthy older adults should assess this causal relationship.

Introduction

Approximately 28.4% of the Japanese population aged ≥65 years in 2019; however, this percentage would increase to 35.3% by 2040 (Japan Ministry of Internal Affairs and Communications, 2020). Older adults are more likely to have reduced functional ability, including the usual gait speed, dynamic ability, or lower extremity strength (Roedersheimer et al., 2016). Further, reduced functional ability was reportedly associated with deterioration of health-related quality of life (HRQOL), a significant public health concern (Trombetti et al., 2016). HRQOL is a multidimensional concept that measures how individuals perceive their physical and mental well-being (Karimi & Brazier, 2016). Given that HRQOL decreases due to reduced functional ability (Bjerk et al.,

2018), reduction of HRQOL should be prevented in older adults.

Previous studies have reported that activities of daily living (ADLs) are either directly or indirectly associated with HRQOL. ADL inability affected HRQOL among older adults with certain chronic conditions, such as dementia, cognitive impairment, Parkinson's disease, or

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survivors of intensive care units after stroke (Andersen et al., 2004; Lawrence et al., 2014; Vest et al., 2011). Moreover, older adults with difficulties or inability to perform their ADLs have been shown to report poor HRQOL after adjusting for medical conditions and other background factors (Barile et al., 2012). The onset of ADL difficulties/inabilities is associated with poor HRQOL (Lyu & Wolinsky, 2017). However, the specific ADL abilities that are strongly associated with reduced HRQOL remains unclear. Understanding relationships between ADL abilities and HRQOL among healthy older adults may help identify potential opportunities for health promotion and prevention and develop promising programs and interventions for improving their HRQOL.

Of ADL abilities, mobility is defined as activity domains including the framework of the International Classification of Functioning, functioning for locomotion, manipulation, stability, and posture change (WHO, 2001). Mobility limitation is affected by age-related declines in lower extremity functions associated with HRQOL reduction (Chung & Flores-Montoya, 2018; Samuel et al., 2012). Consequently, we hypothesized that decreased mobility-related ADL abilities (Sugiura & Demura, 2013), including the activity domains mentioned above, can reduce HRQOL. Therefore, this study aimed to develop a conceptual model that confirms that mobility-related ADL abilities are strongly associated with reduced HRQOL.

Methods

Study Design

The study used a cross-sectional design and was approved by the ethical committee of the Graduate School of Integrated Arts and Science of Hiroshima University (ID: 25-26). All participants provided written informed consent before enrollment in the study. Before initiating the study, all participants were informed with the study procedures and their right to freely reject measurements for any reason anytime.

Participants

Older adults who live in Higashi-Hiroshima City and Hiroshima City, Japan, volunteered as study participants. They were recruited in the Higashi-Hiroshima General Welfare center, the Hakuwa fitness, or center public community centers through many channels such as posters, fliers, or visits to community-based senior citizens' clubs. The recruitment period lasted from December 2011 to October 2012. Inclusion criteria for study participation required individuals to be aged ≥60 years, community-dwelling residents who are independent in ADL without any aids, and able to provide written informed consent. Those with physician-diagnosed severe musculoskeletal, neurological, visual,

sensory, or cognitive disorders that may require active management at district hospitals were excluded.

Sample Size

According to Kline (1998), an adequate sample size should always be 10 times the number of parameters in the path analysis. In mobility-related ADL, four domains were included as observed variables, and a potential variable was directly affected by these variables. HRQOL consisted of eight subscales and a potential variable. We hypothesized the number of parameters in the model as 14. Therefore, the required participants in this study were at least 140.

Outcome Assessment

Body height and mass were measured using a standard tape and weighing scale, respectively. The mobility-related ADL survey used in this study is obtained from the Ministry of Education, Culture, Sports, Science, and Technology of Japan and is used to confirm whether Japanese older adults can safely participate in a physical fitness test, such as grip strength, sit-and-reach distance, the 10-m hurdle walking test, and one-leg standing time with eyes open (Demura et al., 2000). Its effectiveness was reported to be significantly related to age and physical fitness tests (Demura et al., 2000). It consists of 12 ADL items selected from the following four domains: (1) locomotion (five items), (2) manipulation (two items), (3) stability (three items), and (4) posture change (two items). The content of each mobility-related ADL item is described in detail in a previous study (Sugiura & Demura, 2013). The total score ranged from 1 to 36, indicating that the higher score, the greater the ADL independence.

To evaluate HRQOL in participants, the Japanese version (v1.2) of the Medical Outcomes Study 36-item Short-Form Health Survey (SF-36) was administered (Fukuhara, Bito, et al., 1998; Fukuhara, Ware, et al., 1998). The SF-36 consists of the following eight subscales: physical function (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social function (SF), role emotional (RE), and mental health (MH). In addition, based on these eight subscale scores, physical component summary (PCS) and mental component summary (MCS) scores were provided. The scores for each item in the SF-36 are calculated onto a scale from 0 to 100, following the standard SF-36 scoring algorithm. The best scores indicate the most excellent health status.

Blinding

To avoid mixing of the measurement bias, the first author who conducted the study design did not perform the recruitment of study participants and data collection.
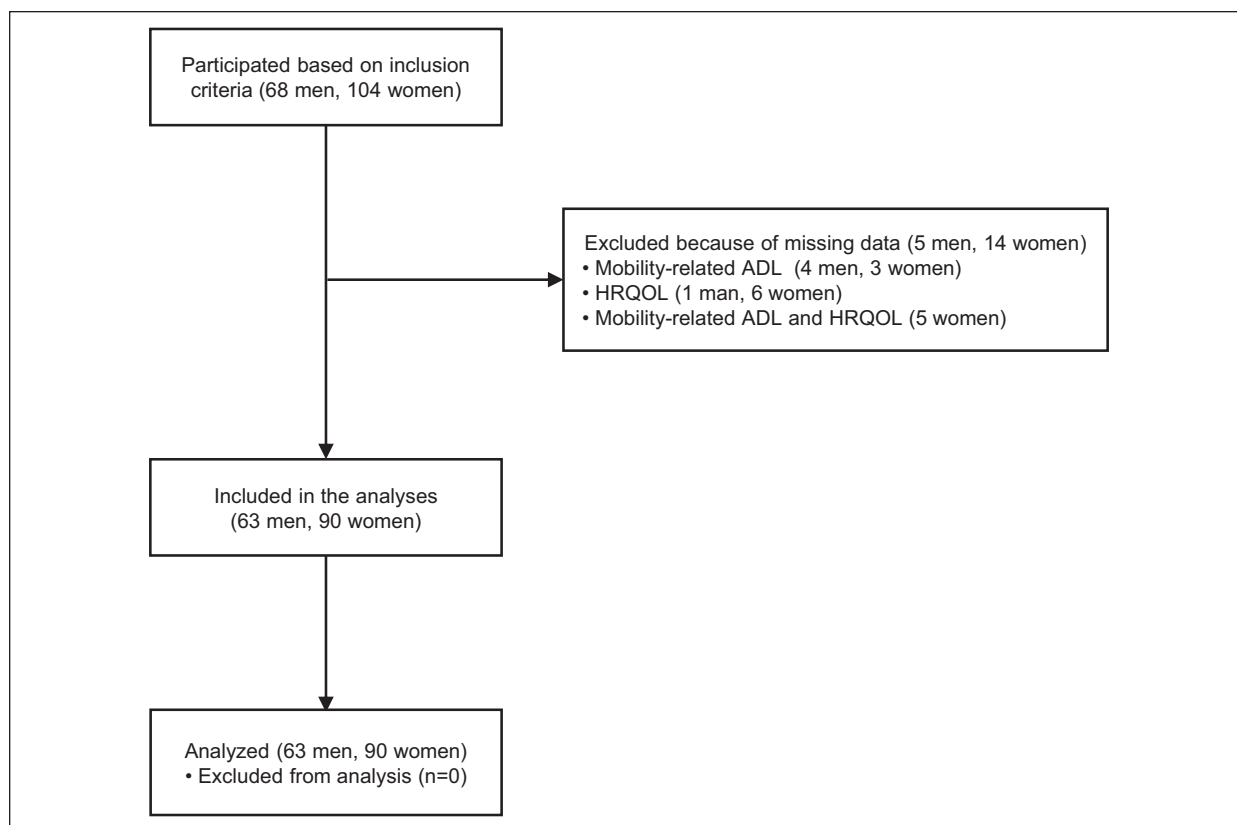
Figure 1. Flow diagram of the participant selection process.
ADL = activities of daily living; HRQOL = health-related quality of life.

Study staff who collected the data and recruited the participants were not informed on the study purpose until study completion.

Statistical Analysis

Before comparing variables between men and women, the data distribution normality was verified with the Shapiro–Wilk test, and variance homogeneity was assessed using the Leven test. Independent sample *t*-tests were conducted if data were homogeneous and normally distributed. Mann–Whitney *U* tests were used whenever normality and variance homogeneity did not exist. Pearson correlation coefficients were used to calculate correlations among variables. Quantitative variables in this study were included in a hypothetical model as follows: mobility-related ADL abilities would influence HRQOL. A structural equation modeling was performed to confirm the fitness of the hypothetical model. The goodness-of-fit of the model was assessed using the following statistical parameters: chi-square value, goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), comparative fit index (CFI), and root mean square error of approximation (RMSEA). A low chi-square value with regard to degrees of freedom with an insignificant *p*-value ($p > .05$); GFI, >0.90; AGFI, >0.90; CFI, >0.95; or RMSEA, <0.06 indicated a good model fit (Hooper et al., 2008). Statistical analyses were

performed using IBM SPSS statistics 22 and IBM SPSS Missing Values (IBM SPSS, Tokyo, Japan) and AMOS 16.0.1 (Arbuckle, 2007).

Results

A total of 172 older adults volunteered based on the inclusion criteria of the study. However, 19 individuals were excluded due to missing data. Thus, a total of 153 participants (63 men, 90 women) were finally analyzed (Figure 1).

Table 1 presents a comparison of characteristics, mobility-related ADL, and HRQOL between older men and women. In older men, all domains and total scores in mobility-related ADL were significantly higher than those of older women, except for the stability domain ($p < .01$). A significant difference was observed for only PF in the HRQOL subscales.

Table 2 shows Pearson's correlations between mobility-related ADL and HRQOL in older men. All domains and total scores in mobility-related ADL were significantly correlated with PF, GH, and PCS in terms of HRQOL ($r = 0.269–0.585$, $p < .05$), whereas no correlations were observed between all domains and total scores in mobility-related ADL and BP of HRQOL.

Pearson's correlations between mobility-related ADL and HRQOL in older women are presented in Table 3. Locomotion, manipulation, and posture change domains

Table 1. Participant Characteristics, Mobility-Related Activities of Daily Living, and Health-Related Quality of Life (mean ± standard deviation).

Variables	Men ($n = 63$)	Women ($n = 90$)	p-Value
Age (years)	70.9 ± 6.0	70.3 ± 5.9	.560[a]
Height (cm)	164.3 ± 6.4	152.2 ± 5.2	<.001[a]
Mass (kg)	62.0 ± 8.6	52.9 ± 8.6	<.001[a]
BMI (kg/m^2)	22.9 ± 2.4	22.9 ± 3.6	.441[a]
Mobility-related activities of daily living (scores)			
Locomotion	13.4 ± 1.6	12.1 ± 2.2	<.001[a]
Manipulation	5.4 ± 0.8	4.9 ± 1.0	.001[a]
Stability	8.0 ± 1.1	7.7 ± 1.2	.085[a]
Posture change	5.1 ± 1.0	4.7 ± 1.0	.007[a]
Total scores	31.9 ± 3.7	29.3 ± 4.4	<.001[a]
Health-related quality of life (scores)			
Physical function	90.3 ± 9.8	84.8 ± 14.7	.005[a]
Role physical	88.2 ± 16.5	81.8 ± 21.3	.079[a]
Bodily pain	74.3 ± 19.9	73.5 ± 23.6	.803[a]
General health	66.7 ± 17.1	65.2 ± 16.2	.572
Vitality	73.7 ± 16.8	68.4 ± 18.3	.114[a]
Social function	90.5 ± 15.8	86.8 ± 16.7	.089[a]
Role emotional	89.0 ± 16.9	85.1 ± 18.8	.158[a]
Mental health	80.0 ± 13.6	74.8 ± 17.4	.090[a]
Physical component summary	48.9 ± 8.3	45.9 ± 10.8	.069[a]
Mental component summary	54.8 ± 7.3	53.5 ± 8.1	.287

[a]The Mann-Whitney *U* test.

and mobility-related ADL total scores were significantly correlated with all HRQOL subscales. In addition, stability domain was significantly correlated with PF, RP, BP, GH, VT, RE, and PCS in HRQOL.

Results of a path analysis for the hypothetical model are shown in Figure 2. In this study, a path analysis was conducted by treating samples as a general elderly population, because the sample size becomes smaller and the beta error increases when samples are separated for men and women. Furthermore, the path analysis was treated by PF and GH of HRQOL only because the beta error increases when including other HRQOL subscales. A potential variable including only PF and GH in eight HRQOL subscales was designated as physical health in this study. The chi-square value was not significant (chi-square = 9.463, p = .305), and the goodness-of-fit indices were high, implying that the model was validated (GFI, 0.981; AGFI, 0.949; CFI, 0.996; and RMSEA, 0.035). Results of this analysis showed that mobility-related ADL abilities significantly influenced the physical health including only PF and GH.

Discussion

This study aimed to develop a conceptual model that confirms that mobility-related ADL abilities are strongly associated with reduced HRQOL. The result obtained from our path analysis showed that mobility-related ADL, including four domains, significantly influenced the physical health consisting PF and GH only.

Previous studies reported that HRQOL reductions were associated with the occurrence of ADL difficulties/inabilities (Lyu & Wolinsky, 2017), muscle strength loss, poor functional ability (Samuel et al., 2012), and physical pathologies (Olsson et al., 2019). In our model, four functional activities were assumed as the component of mobility-related ADL abilities and eight domains as that of the HRQOL. The model was used to estimate the structural relationship between mobility-related ADL abilities and HRQOL, and thus, we believe the results of this analysis are novel findings. Results of the path analysis promote a multidimensional understanding of the relationship between mobility-related ADL abilities and HRQOL. Our path analysis result clearly revealed that mobility-related ADL abilities, including locomotion, manipulation, stability, and posture change domains in healthy older adults directly affected the physical health of HRQOL.

Considering that restoring the ability to perform ADLs independently is difficult in older adults with ADL disabilities (Sonoda et al., 2005), healthy older adults' ADL abilities should be maintained as long as possible. In addition, the lower locomotive function of ADL was associated with poor HRQOL (Huang et al., 2018). ADL level was higher for community-dwelling older adults with superior HRQOL (Takemasa et al., 2017). Our study shows the empirical evidence that the higher locomotive, manipulative, stabilize, and posture change function of mobility-related ADL should be sustained in order to prevent the decrease in physical health of HRQOL in healthy older adults.

Table 2. Pearson's Correlations between Mobility-Related Activities of Daily Living and Health-Related quality of Life in Older Men (n = 63).

Variables	Physical function		Role physical		Bodily pain		General health		Vitality		Social function		Role emotional		Mental health		Physical component summary		Mental component summary	
	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value
Locomotion	0.569	<.001	0.468	<.001	0.126	.325	0.373	.003	0.392	.001	0.155	.224	0.483	<.001	0.376	.002	0.490	<.001	0.256	.043
Manipulation	0.488	<.001	0.253	.045	0.228	.073	0.390	.002	0.453	<.001	0.246	.052	0.297	.018	0.347	.005	0.300	.017	0.395	.001
Stability	0.585	<.001	0.228	.073	0.199	.119	0.292	.020	0.071	.581	0.179	.161	0.217	.087	0.213	.094	0.383	.002	0.100	.436
Posture change	0.446	<.001	0.223	.079	0.168	.189	0.399	.001	0.326	.009	0.178	.163	0.232	.067	0.264	.037	0.269	.033	0.298	.018
Total scores	0.627	<.001	0.371	.003	0.206	.105	0.432	<.001	0.365	.003	0.214	.093	0.386	.002	0.362	.004	0.448	<.001	0.300	.017

Table 3. Pearson's Correlations between Mobility-Related Activities of Daily Living and Health-Related Quality of Life in Older Women ($n = 90$).

	Variables	Physical function		Role physical		Bodily pain		General health		Vitality		Social function		Role emotional		Mental health		Physical component summary		Mental component summary	
	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value	r	p-Value
Locomotion	0.703	<.001	0.531	<.001	0.480	<.001	0.525	<.001	0.511	<.001	0.274	.009	0.385	<.001	0.329	.002	0.610	<.001	0.303	.004
Manipulation	0.542	<.001	0.534	<.001	0.445	<.001	0.475	<.001	0.345	.001	0.235	.026	0.282	.007	0.246	.019	0.553	<.001	0.201	.057
Stability	0.568	<.001	0.339	.001	0.412	<.001	0.314	.003	0.305	.003	0.168	.114	0.228	.031	0.165	.120	0.460	<.001	0.141	.186
Posture change	0.468	<.001	0.396	<.001	0.436	<.001	0.371	<.001	0.347	.001	0.286	.006	0.291	.005	0.216	.041	0.460	<.001	0.228	.031
Total scores	0.726	<.001	0.564	<.001	0.545	<.001	0.533	<.001	0.487	<.001	0.292	.005	0.380	<.001	0.305	.003	0.654	<.001	0.277	.008
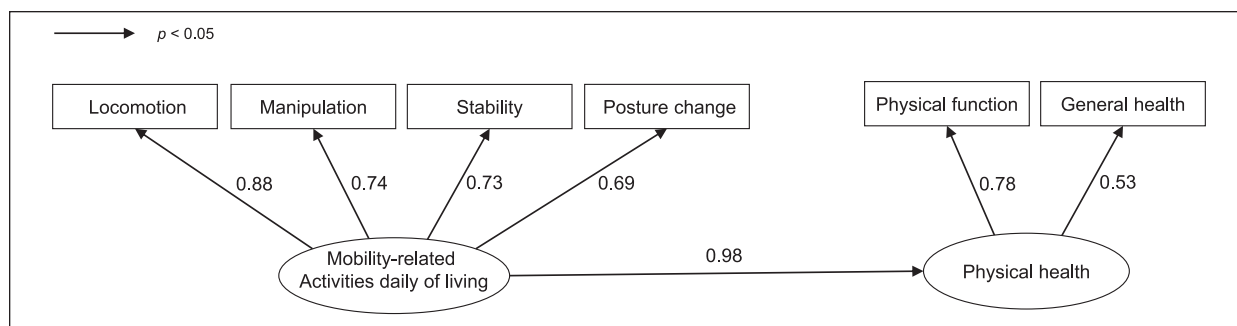
Figure 2. Results of a path analysis for the hypothetical model.

A previous study showed that self-reported health status affected HRQOL more than ADL (Kim et al., 2018). Moreover, in a prospective cohort study (Vest et al., 2011), both depression and ADL dependence were significantly associated with PCS, but only depression was significantly associated with MCS. A cross-sectional study on 249 middle-aged and older adult residents in a rural community reported that self-efficacy showed a significant direct effect on HRQOL (Lee et al., 2014). Thus, the small number of psychological and spiritual factors was not related to HRQOL. In HRQOL measured using SF-36, VT, SF, RE, and ME are mental scales with positive weights in the MCS scoring. Any direct, significant relationships between these scales and mobility-related ADL are not shown in the path analysis result. In this study, the mobility-related ADL survey was conducted, but overlooked psychological and mental factors related to ADL. Therefore, to increase both PCS and MCS in HRQOL, not only mobility-related ADLs but also psychological factors should be considered.

Our study had several limitations. First, a strict causal relationship was not determined in this study because of its cross-sectional design. To reliably demonstrate a causal relationship between mobility-related ADL and HRQOL, either a cohort study or a clinical trial should be conducted to observe changes in HRQOL due to interventions for mobility-related ADL. Second, the sample size was small. Separate path analysis was not performed for men and women due to the small sample size. In our study, correlations among all mobility-related ADL domains and BP in men and women differed. These differences suggest that the effect of mobility-related ADL abilities on HRQOL may vary according to gender. Further study with a large number of samples is needed to reveal results of men and women, respectively.

Despite these limitations, our results have potentially important implications for HRQOL in healthy older adults. Previously, the relationship between ADL disability and HRQOL reduction has been reported (Barile et al., 2012; Lyu & Wolinsky, 2017). Based on our results, instructions and/or exercise interventions targeting the locomotive, manipulative, stabilize, and posture change function of ADL abilities on healthy older adults are recommended because preservation of mobility-related ADL can help maintain the HRQOL physical health.

Conclusions

We developed a conceptual model to reveal the relationship between mobility-related ADL abilities and HRQOL among healthy older adults. Mobility-related ADL abilities consisted of locomotion, manipulation, stability, and posture change especially influencing the physical health, that is, PF and GH. Further longitudinal studies with large sample size on healthy older adults should assess a causal relationship between mobility-related ADL abilities and HRQOL.

Author Contributions

HJ contributed to the study design, statistical analysis, result interpretation, and manuscript preparation. ST, YI, and MY participated in the study design and reviewed the manuscript. RT contributed to the study design, statistical analysis, and result interpretation. All authors read and approved the final manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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